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REASSESSMENT OF NORTHERN GEOGRAPHIC LIMITS FOR DECAPOD CRUSTACEAN SPECIES IN THE CAROLINIAN PROVINCE, USA; SOME MAJOR RANGE EXTENSIONS ITEMIZED

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Abstract.—Trawl samples taken in 1977 from the Cape Hatteras–Cape Lookout, North Carolina, area, together with other collections from the Carolinas during the past 15 years, have added about 70 species to the known decapod crustacean fauna of the region. Significant northward extensions of range for selected species are given. Recomputation of northern range limits given by Williams in 1965 confirms that Cape Lookout marks a zone of greater zoogeographic change than does Cape Hatteras. The area as a whole is characterized by thermal barriers, but variable substrates off Cape Lookout support a more diverse warm water fauna there.

Introduction

Many decapod crustaceans recently collected in the vicinity of a thermal front north of Cape Hatteras, North Carolina, represent significant northward extensions of ranges for species with Caribbean affinities. These extensions, combined with others reported since 1965 or known from unreported studies, are sufficiently numerous to warrant reevaluation of Williams's (1965a) summary and recomputation of his Table 1.

During 1977, a group from the University of Wisconsin under the direction of J. J. Magnuson collected trawl samples aboard the Duke University NSF sponsored vessel, R/V *Eastward*, as part of a study of this thermal front. We acknowledge funding of the immediate project by National Science Foundation Biological Oceanography Grant No. OCE77-08531 to the University of Wisconsin. The efforts and generosity of many individuals during the past 15 years have resulted in specimens and records that contribute to an increased knowledge of the Carolinian fauna. Much of such material has come through auspices of the Duke University Marine Laboratory from sampling aboard the R/V *Eastward* and *Beveridge*, and the University of North Carolina Institute of Marine Sciences from the R/V *Machapunga*, M/V *Ensign* and *Seven Brothers*, as well as miscellaneous collecting. Some information still to be reported in detail has come from the South Carolina Wildlife and Marine Resources MARMAP Program.

Material and Methods

The samples collected during the June and August, 1977, cruises of R/V *Eastward* (Nos. E-2-77 and E-5-77), consisted of 15-minute bottom trawls

with a 9.14-m (30-ft) semi-balloon otter trawl having a 9.45-m headrope and an 11.6-m footrope. The body of the trawl was made of 3.8-cm nylon stretch mesh and the cod end liner of 0.6-cm nylon stretch mesh.

In June, 152 samples were collected east of Cape Lookout, N.C., and from the Cape Hatteras vicinity at depths of 28–40 m. In August, 176 samples were collected from the same areas.

Decapod crustaceans collected were fixed in 14% formalin, later preserved in 70% ethanol, and stored in either the University of Wisconsin-Madison Zoological Museum, or the National Museum of Natural History, Washington, D.C.

Results

Species not previously known from North Carolina shelf waters and representing major range exensions are listed in Table 1.

Apart from a single collection made in 1876 off the Massachusetts coast (USNM 58087), *Tozeuma serratum* A. Milne Edwards was not known to occur north of the Gulf of Mexico. During both June and August, *T. serratum* was commonly collected off the Cape Lookout and Cape Hatteras area.

Periclimenes iridescens Lebour, *Processa hemphilli* Manning and Chace, and *Pylopagurus holthuisi* Provenzano were regularly found in trawl samples at Cape Lookout and Cape Hatteras during both June and August. *Periclimenes pedersoni* Chace was regularly collected at Cape Lookout, while other species listed in Table 1 were represented in fewer than six samples (<5% of samples), or had been previously collected by others.

Two incomplete female specimens of *Processa* (carapace length 5.88 and 5.25 mm including rostrum) are closest to *P. guyanae* Holthuis in the keys to species of *Processa* given by Manning and Chace (1971) and Hayashi (1975). The smaller, more complete specimen lacks the left second leg but agrees with most other key characters for *P. guyanae* and with its original description (Holthuis, 1959). An exception is found in proportional lengths of distal articles of the fifth leg; the smaller specimen has the propodus 2.2 times the length of the dactyl rather than 4 times as in *P. guyanae*. Distal articles of the antennal peduncles are missing in both specimens, and in the larger specimen, identified by inference, most of the legs are missing.

The 13 species listed in Table 1 represent northern range extensions of forms having Caribbean affinities. Breeding populations of at least six of these species in North Carolina waters are suggested by the presence of gravid females.

Since Williams (1965a) computed the range limits for species of decapod crustaceans occurring in Carolinian shelf waters, 71 additional species have been recognized from the region (Williams, 1965b, 1974a, b; Williams *et al.*,

Table 1. Major range extensions.

Species	Range Extension	Bottom temp. °C	Specimen data	Previous northern limits and citation or USNM record
Periclimenes iridescens Lebour	NE C. Hatteras 35°32.9′N, 75°11.9′W 32 m 12 Aug. 1977 Eastward #33110	15.3	1 male	Off Panama City, Florida (Chace, 1972)
Periclimenes pedersoni Chace	E C. Lookout 34°35.5′N, 75°05.5′W 35 m 3 Aug. 1977 Eastward #32687	24.9	2 females ov.	Off West Florida, Bahamas (Chace, 1972)
Alpheus floridanus Kingsley	SE C. Hatteras 35°01.5′N, 75°30.8′W 38 m 13 Aug. 1977 Eastward #33202	25.3	1 male 1 female ov.	Northern Gulf of Mexico (Chace, 1972)
Tozeuma serratum A. Milne Edwards	NE C. Hatteras 35°32.1′N, 75°11.8′W 32 m 10 Aug. 1977 Eastward #33002	17.3	1 male 1 female ov.	Mass. Coast USNM 58087 Gulf of Mexico (Chace, 1972)
Processa aff. *P. guyanae* Holthuis	E C. Lookout 34°38.2′N, 75°09.0′W 33 m 4 Aug. 1977 Eastward #32701	26.0	2 females	Off Surinam (Holthuis, 1959)

Table 1. Continued.

Species	Range Extension	Bottom temp. °C	Specimen data	Previous northern limits and citation or USNM record
Processa hemphilli Manning and Chace	NE C. Hatteras 35°32.1′N, 75°11.8′W 32 m 10 Aug. 1977 Eastward #33002	17.3	1 male 5 females ov.	Off Southwest Florida (Manning & Chace, 1971)
Cancellus ornatus Benedict	ESE C. Fear 34°43.0′N, 70°40.0′W 90–110 m 27 Apr. 1965 Eastward #1087	—	1 female ov.	Off East Coast, Florida (Mayo, 1973)
Pylopagurus holthuisi Provenzano	NE Oregon Inlet 35°01.7′N, 75°11.2′W 33 m 9 Aug. 1977 Eastward #32943	13.7	1 male	Off South Carolina USNM 102503
Iridopagurus carribensis (A.M.E. & Bouvier)	E C. Lookout 34°36.5′N, 75°06.7′W 30 m 3 Aug. 1977 Eastward #32685	25.7	1 male	Off South Carolina (Williams, 1965) (de St. Laurent-D., 1966)
Raninoides loevis (Latreille)	SE C. Hatteras 35°03.2′N, 75°35.1′W 30 m 24 Oct. 1977 Eastward #33844	19.8	1 male C.L. 29.6 C.W. 16.2 mm	Gulf of Mexico (Bullis & Thompson, 1965) USNM 121663

Table 1. Continued.

Species	Range Extension	Bottom temp. °C	Specimen data	Previous northern limits and citation or USNM record
Coelocerus spinosus A.M.E.	SE C. Hatteras 35°03.2′N, 75°30.3′W 27 m 13 Aug. 1977 Eastward #33186	25.2	1 male juv.	East Coast, Florida USNM 169203
Hemus cristulipes A.M.E.	E C. Lookout 34°37.1′N, 76°13.0′W 38 m 1 June 1977 Eastward #31701	23.6	1 male	Gulf of Mexico (Bullis & Thompson, 1965) USNM 101581
Speocarcinus carolinensis Stimpson	E C. Hatteras 35°03.5′N, 75°25.7′W 36 m 14 Aug. 1977 Eastward #31730	23.1	1 female ov.	Off Charleston, South Carolina (Williams, 1965)

Table 2. Northern geographic ranges of decapod crustaceans found in the Carolinas.

Family	No. of species	North Cape Cod	Cape Cod	Middle Atlantic	Cape Hatteras	Cape Lookout	Cape Fear
Penaeidae	16	–	–	5	8	1	–
Sergestidae	2	1	–	–	1	–	–
Pasiphaeidae	3	1	–	–	2	–	–
Palaemonidae	16	2	2	1	4	6	1
Gnathophyllidae	1	–	1	–	–	–	–
Alpheidae	12	–	–	2	3	7	–
Ogyrididae	2	–	–	2	–	–	–
Hippolytidae	12	1	3	2	–	5	1
Processidae	6	–	–	–	3	3	–
Pandalidae	1	–	–	–	–	1	–
Crangonidae	1	1	–	–	–	–	–
Stenopodidae	1	–	–	–	–	–	1
Palinuridae	1	–	–	–	1	–	–
Scyllaridae	4	–	1	1	1	1	–
Callianassidae	4	1	1	–	–	1	1
Axiidae	2	–	–	–	–	2	–
Laomediidae	1	–	–	–	–	1	–
Upogebiidae	1	1	–	–	–	–	–
Paguridae	26	3	2	3	7	9	2
Galatheidae	6	–	1	1	1	3	–
Porcellanidae	8	–	2	1	3	1	1
Albuneidae	3	–	–	–	2	1	–
Hippidae	2	–	1	–	–	–	1
Dromiidae	4	–	–	–	4	–	–
Homolidae	1	–	1	–	–	–	–
Latreillidae	1	–	1	–	–	–	–
Dorippidae	5	–	1	–	1	2	1
Calappidae	9	1	1	1	3	3	–
Leucosiidae	9	–	1	1	4	3	–
Raninidae	4	–	–	–	1	2	1
Portunidae	18	2	5	4	2	5	–
Cancridae	2	2	–	–	–	–	–
Majidae	41	3	4	2	13	17	2
Parthenopidae	9	–	2	1	2	4	–
Xanthidae	27	2	3	–	8	12	2
Goneplacidae	7	–	–	–	5	1	1
Pinnotheridae	10	–	6	1	–	1	2
Grapsidae	7	1	1	1	1	3	–
Ocypodidae	4	–	3	1	–	–	–
Palicidae	2	–	–	–	2	–	–
No. species limit	—	22	45	30	82	95	17
Percent total	—	7.6	15.5	10.3	28.2	32.6	5.8

1968; Williams and Wigley, 1977; Guinot, 1969a, b, c; Pérez Farfante, 1969, 1971a, b, 1977; Pérez Farfante and Bullis, 1973; Manning and Chace, 1971; Chace, 1972; Mayo, 1973; USNM unpublished data). In addition, 30 other range extensions of less than 100 mi are known in the Cape Lookout–Cape Hatteras area (Herbst unpublished data). (Detailed distributional records for some species in the Carolinian Province from off Cape Fear to Cape Canaveral are also to be documented in forthcoming reports [South Carolina Wildlife Marine Resources Department, MARMAP Program]). Incorporating these new data, the northern geographic limits for the 291 decapod crustacean species known to reside in Carolinian shelf waters are grouped by family and listed in Table 2. Only verified records compared with identified material are included in this analysis.

Results indicate that the Cape Lookout–Cape Hatteras area is a major geographic barrier to 60.8% of the Carolinian decapod fauna (177 species). A secondary barrier is found at Cape Cod, Mass., where 46.4% of the fauna (45 of 97 species) that traverses the Cape Lookout–Cape Hatteras barrier reaches its northern limit.

Discussion

Williams (1965a) determined the northern range limits of the Carolinian decapod fauna, then represented by 220 species, and concluded that the Cape Lookout vicinity was an area of greater zoogeographic change in northward distribution of decapod crustaceans than that at Cape Hatteras. However, there was doubt as to whether this change was evidence for a real barrier region or a consequence of the greater collecting effort in the Cape Lookout vicinity. Our results are almost identical with those of Williams, thereby supporting his earlier findings.

Temperature has been thought to be a major factor limiting the distribution of animals in the Cape Lookout–Cape Hatteras region (Cerame-Vivas and Gray, 1966; Bowman, 1971; Briggs, 1974). At Cape Hatteras, southerly flowing cold Virginian water is diverted eastward by the northerly flowing Gulf Stream which is frequently less than 10 km from shore (Stefansson and Atkinson, 1967; Parker, 1976). Occasionally, this cold water spills past Cape Hatteras and moves inshore and southward as far as Cape Lookout where it is either diverted eastward by the shoals or moves inshore into Onslow Bay (Cerame-Vivas and Gray, 1966; Stefansson *et al.*, 1971; Hunt *et al.*, 1977). Species living in the Cape Hatteras vicinity would be occasionally exposed to intrusions of cold Virginian water. Evidence for at least temporary tolerance to cold water of decapod species having northern range limits there is indicated by the presence of some of these species in stable, cool Virginian water (June temperatures of less than 14°C) just north of Cape Hatteras.

These species include such tropical forms as *Solenocera atlantidis* Burkenroad, *Porcellana sayana* (Leach), *Dardanus insignis* (Saussure), *Iliacantha intermedia* Miers, *Portunus spinicarpus* (Stimpson), *Stenocionops furcata coelata* (A. Milne Edwards), *Mesorhoea sexspinosa* Stimpson, and *Euryplax nitida* Stimpson.

It is possible that a barrier in the Cape Lookout vicinity may be formed by the southernmost penetration of cold Virginian water, but Menzies *et al.* (1966), working on a submerged reef southeast of Cape Lookout, stated that the reef area is beyond the influence of cold shelf waters.

Sediment type and stability may be other factors influencing decapod crustacean distribution in the area near both capes. The Cape Lookout vicinity is characterized by a great diversity of bottom types including *Lithothamnion* reefs (Menzies *et al.*, 1966; Cain, 1972), tropical coral (MacIntyre and Pilkey, 1969), offshore scallop beds (Schwartz and Porter, 1977), and a virtual mosaic of sand grades. In contrast, the bottom type near Cape Hatteras is characterized by shifting fine sand and silt, with only a few small patches of coarse sand and shell fragments (Newton *et al.*, 1971; Hunt *et al.*, 1977). More species requiring specific physical habitats might therefore be expected to occur near Cape Lookout than near Cape Hatteras, giving the appearance of selective barriers to distribution at the capes. Vernberg and Vernberg (1970), working in the Cape Lookout–Cape Hatteras region similarly suggested that factors other than temperature (substrate and depth) may limit the northern distribution of species with southerly affinities.

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